Meta-Genesis. Towards a Biology without Matter, based on Pure Logic

Multi-Scale Numerical Invariants and Fractal Properties of the Genetic Code

Abstract and compilation

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Abstract: After several years of research, I am completing the Meta-Genesis cycle — Toward a Biology Without Matter, Based on Pure Logic — a work in which I identified a sequence of numerical invariants linking the chemistry of the stars to molecular biology.

This sequence spans every scale:
→ the stars (where the CHON elements — carbon, hydrogen, oxygen, and nitrogen — are born),
→ the nucleic acids (adenine, guanine, thymine, and cytosine),
→ the theoretical duplets proposed by Francis Crick,
→ the triplet codons,
→ up to a hypothetical quaternary code,
→ but also the amino acids, and even viruses and alternative systems considered in exobiology (silicon, phosphorus, sulfur).

The same constants reappear at every level — as if life were written in the same mathematical grammar as the matter from which it arose.

That's what I call: **A Unified Theory of Biological Information — From Stars to Codons**.

Building on the work of Turing, von Neumann, and Shannon, I have mathematically demonstrated that the genetic code behaves as a universal logical automaton — a system that self-organizes from its own syntax. From stars to codons, life computes its own coherence — and life is, above all, information before it is chemistry.

Introduction

After several years of research, I am completing the *Meta-Genesis* cycle — a theoretical proposition toward a biology without matter, grounded in pure logic. I explore a sequence of **multi-scale numerical invariants** linking stellar chemistry to the fundamental structures of life: nitrogenous bases, theoretical doublets (Crick), triplets (codons), a hypothetical quaternary code, amino acids, and even viruses or alternative exobiological systems.

The constants I identify — notably **1, ~96–97, and 128** (which sum to **+225.5**, later observed in *Multiscale Packet Distributions*) — emerge at the atomic level (CHON), persist within nucleic bases (A, C, G, T/U), structure the codons, and are observable in **fractal architectures** embedded in the genetic sequence. They reveal an **autonomous arithmetic coherence**, independent of classical biological constraints.

Part 1 – Combinatorial and Atomic Analysis

I demonstrate that the genetic code exhibits a **fractal and combinatorial structure**, shaped by invariants derived from the atomic properties of its components. By translating bases and codons into values based on a mathematical lens — the product of protons × electrons × neutrons — I show that biology rests on a **stable mathematical matrix**: 1, ~96–97, and 128. These constants are not arbitrary; they arise naturally from atomic combinatorics and impose an **internal grammatical constraint** on the structure of life. Furthermore, these numerical signatures allow the code to be interpreted as encoding **stable binary states (ON/OFF)** across the sequence — a logical scaffolding that predates any biochemical function. This binarization reveals an inherent **digital structure** within the genome itself, suggesting that life processes operate, at their root, through **information states**, not molecular reactions.

Mathematical lens method

$$v_i = p_i \cdot n_i \cdot e_i$$

v = logical value of a codon raised to the cube
p = number of protons
n = number of neutrons
e = number of electrons

The value, once cubed, is then divided by 4 in order to reflect the quaternary nature of the system (four main atoms, four bases, codons organized into groups of four):

$$f(n) = \frac{n^3}{4}$$

This methodology brings out constant numerical patterns that appear to correspond to logical transitions. The underlying hypothesis is that the architecture of DNA encodes ON/OFF-type states within a logical sequence, organizing life as a natural finite automaton.

PROPOSAL FOR A THEORETICAL CODONIC UNIT (TCU)

	Series of numbers – subatomic particles raised to the cube	Combinaison	Family	Number of particles cubed and divided by 4	Constant numerical patterns
	1	Electron	Particle	0.25	Does not apply.
+26	27 (3 quarks)	Proton	Particle	6.75	
+0	27 (3 quarks)	Neutron	Particle	6.75	
	1	Hydrogène	Atom	0.25 ou 1 ?	**1**
+215	216	Carbone	Atom	54	+54
+127	343	Azote	Atom	85.75	+31.75
+169	512	Oxygène	Atom	128	+42.25 (note : 54 + 42.25 = **96.25**, et 54 + 31.75 + 42.25 = **128**)
+1898	2410	C	Nucleic base	602.5	
+386	2796	T	Nucleic base	699	**+96.5**
+4	2800	A	Nucleic base	700	**+1**
+512	3312	G	Nucleic base	828	**+128**
+1508	4820	CC	Theoretical ancient code with doublets	1205	
+386	5206	TC-CT	Theoretical ancient code with doublets	1301.5	**+96.5**
+4	5210	AC-CA	Theoretical ancient code with doublets	1302.5	**+1**
+382	5592	TT	Theoretical ancient code with doublets	1398	+95.5
+4	5596	AT-TA	Theoretical	1399	+1

			ancient code with doublets		
+4	5600	AA	Theoretical ancient code with doublets	1400	+1
+122	5722	CG-GC	Theoretical ancient code with doublets	1430.5	+30.5 (note : 95.5 + 1 + 1 + 30.5 = **128**)
+386	6108	TG-GT	Theoretical ancient code with doublets	1527	**+96.5**
+4	6112	AG-GA	Theoretical ancient code with doublets	1528	**+1**
+512	6624	GG	Theoretical ancient code with doublets	1656	**+128**
+606	7230	CCC	Codon	1807	
+386	7616	CCT-TCC-CTC	Codon	1904	**+97**
+4	7620	CCA-ACC-CAC	Codon	1905	**+1**
+382	8002	TCT-CTT-TTC	Codon	2000	+95
+4	8006	TCA-ACT-CTA-ATC-CAT-TAC	Codon	2001	+1
+4	8010	ACA-CAA-AAC	Codon	2002	+1
+122	8132	CCG-GCC-CGC	Codon	2033	+31 (note : 95 + 1 + 1 + 31 = **128**)
+256	8388	TTT	Codon	2097	+64
+4	8392	TTA-ATT-TAT	Codon	2098	+1
+4	8396	ATA-TAA-AAT	Codon	2099	+1

+4	8400	AAA	Codon	2100	+1
+518	8518	TCG-GCT-CTG-GTC-CGT-TGC	Codon	2129	+28 (note : 64 + 1 + 1 +1 +28 = **95**)
+4	8522	ACG-GCA-CAG-GAC-CGA-AGC	Codon	2130	**+1**
+382	8904	TTG-GTT-TGT	Codon	2226	+96
+4	8908	ATG-GTA-TAG-GAT-TGA-AGT	Codon	2227	+1
+4	8912	AAG-GAA-AGA	Codon	2228	+1
+122	9034	GCG-CGG-GGC	Codon	2258	+30 (note : 96 + 1 +1 + 30 = **128**)
+386	9420	GTG-TGG-GGT	Codon	2355	**+97**
+4	9424	GAG-AGG-GGA	Codon	2356	**+1**
+512	9936	GGG	Codon	2484	**+128**

Remarkably, the 64 codons of the genetic code lend themselves perfectly to this Boolean interpretation. Just as electronic engineers apply the first law of Boolean algebra to optimize an on/off circuit, one can view the codon table as a logical schema: each triplet acts as a binary input pattern, and the corresponding amino acid is the deterministic “output” of this logical operation. All combinaisons were tested with TCAG (all combinaisons available in the original article and data availability part 1).

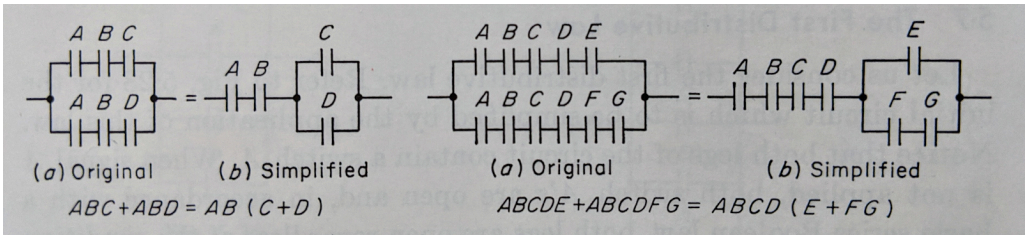

Illustration of the First Distributive Law
Binary Arithmetic and Boolean Algebra, p. 82 (Angelo C. Gillie, 1965).

Ref. Kayser-Cuny, V. (2025). (Part 1) Multi-Scale Numerical Invariants and Fractal Properties of the Genetic Code: A Combinatorial and Atomic Analysis. Zenodo. https://doi.org/10.5281/zenodo.17068843

Part 2 – Internal Constraints and Universal Grammar

In this second phase, I demonstrate that the genetic code is governed by **strict internal constraints**, revealing an **implicit grammar** — like an autonomous language, where the assembly of information units follows a syntax. The **numeric packet distributions**, codon/amino acid groupings, and recurring patterns across scales (doublet → triplet → quaternary) expose the existence of a **universal biological grammar**.

This grammar remains stable despite known variants of the genetic code: observed deviations retain the underlying constants, as if evolution were merely a surface modulation atop a **fixed logical structure**. I argue that the genome reflects more than biological function: it encodes a **syntax-based organizational system**, predating metabolism. Within this framework emerges the constant **Δ = +225.5**, precisely the sum of 1, 96.5, and 128. Δ = 225.5 represents the equilibrium point between atomic and codonic numerical states.

Explanations: Matrix Formalization of the "Isolated Blocks" and Their Self-Generation Based on the Groups of 1 in the Theoretical Codonic Table.

Generator Vector (Minimal Core) The nine isolated blocks are grouped into a generator column vector, representing the minimal structural core of the system. This vector serves as the initial condition from which all subsequent additive and predictive values can be derived. Through successive matrix operations (additions and recursive combinations), the system reconstructs part of its own invariant structure, demonstrating self-generation and internal coherence within the codonic framework.

$$\mathbf{b} = \begin{bmatrix} 602.5 \\ 828 \\ 1205 \\ 1430.5 \\ 1656 \\ 1807 \\ 2033 \\ 2258 \\ 2484 \end{bmatrix} \in \mathbb{R}^9$$

This vector represents the minimal fractal basis —
the set of fundamental "blocks" from which the system's structure emerges.

Run-length (RL) distributions (Broken fractal symmetry and analogy with particle physics)

The organization of numerical groupings derived from the Theoretical Codonic Unit, when the invariant 128 is neutralized, reveals a layered progression: 1, 3, 6, 9. This sequence follows the logic of triangular numbers and directly mirrors the combinatorial structure of Pascal's triangle (1, 3, 6, 10).

Construction by Packets: Triangularization of Consecutive Numbers

Packet (n)	Values Contained in Each Packet
Packet 1	602.5, 828, 1205, 1430.5, 1656, 1807, 2033, 2258, 2484
Packet 2	699, 700 (= 1399), 1301.5, 1302.5 (= 2604), 1904, 1905, 2129, 2130
Packet 3	1398, 1399, 1400, 2000, 2001, 2002, 2226, 2227, 2228
Packet 4	2097, 2098, 2099, 2100

Number of Elements per Packet

Packet	Number of Elements
1	9
2	6
3	3
4	1

However, instead of culminating at 10, the sequence stops at 9. This deficit of one unit constitutes a case of broken fractal symmetry: the global model — the universal binomial law — is indeed present, but its expression is constrained, halted before reaching full development. This situation is reminiscent of spontaneous symmetry breaking in particle physics. In the Standard Model, the fundamental equations predict perfect symmetry among particles. Yet this symmetry is broken through the Higgs mechanism: an internal constraint within the system imparts mass to particles, at the cost of deviating from the ideal theoretical symmetry.

Analogously, the combinatorial progression observed in the genetic code expresses a mathematical universality (the triangular sequence), but its expansion is curtailed by an internal constraint that limits its growth. In geometric terms, the sequence does not form a perfect tetrahedron, but rather a truncated quasi-tetrahedron. Thus, this rupture does not represent a flaw but a systemic signature: life does not apply mathematical laws in a raw manner — it modulates them. In this numerical framework, life emerges as a compromise

between universal symmetry (Pascal's combinatorics) and local constraint (the internal regulation of the code).

Parallel with the Quantum Structure of Electronic Orbitals

The numerical sequence highlighted in the invariant table — 1, 3, 6, 9 — can be interpreted through the lens of electronic quantization.

In quantum mechanics, electrons within an atom occupy shells (*n = 1, 2, 3, …*) and subshells (*s, p, d, f*), each corresponding to a limited number of orbitals:

- s → 1 orbital, 2 electrons (general rule: $2n^2$)
- p → 3 orbitals, 6 electrons
- d → 5 orbitals, 10 electrons
- f → 7 orbitals, 14 electrons

These orbitals represent directional degrees of freedom in space, each capable of accommodating two electrons of opposite spins.

Remarkably, the progression observed within the invariant system mirrors this logic directly:

- **1** → the single electron, the fundamental ground state, as in hydrogen (*$1s^1$* configuration).
- **3** → the directional triplet, equivalent to the three *p* orbitals (p_x, p_Y, p_z), forming an orthogonal geometric basis.
- **6** → doubling of this triplet by spin (*3 orbitals × 2 electrons = 6*), the exact signature of the *p* subshell.
- **9** → the next step, which would theoretically correspond to the onset of the *d* subshell (*5 orbitals × 2 = 10*), yet stops one unit earlier. This truncation represents a broken symmetry, precisely analogous to the triangular growth pattern where the expected value is replaced by 9.

Thus, the sequence 1–3–6–9 reveals a profound isomorphism between the combinatorics of invariants and the quantum structure of electronic orbitals. It expresses both:

- a fractal universality, where the same mathematical laws govern numbers, orbitals, and codons, and
- an internal limitation (broken symmetry at 9) that imparts a unique systemic signature.

This parallel suggests that the combinatorial logic identified within the genetic code is not confined to the biological domain. Rather, it extends the organizational principles of atomic matter itself — from the quantization of electrons in orbitals to the quantization of codons within the genome.

Comparison between the Sequence of Invariants and Electronic Orbitals

Sequence of Invariants	Combinatorial Interpretation	Electronic Structure	Number of Orbitals / Electrons
1	Seed, isolated ground state	*s* subshell	1 orbital → 2 max electrons (but starts with 1)
3	Directional triplet	*p* subshell (p_x, p_y, p_z)	3 orbitals → 6 electrons
6	Doubling by spin (3×2)	Complete *p* subshell	6 electrons (2 per orbital)
9	Truncated quasi-volume, rupture	Beginning of *d* subshell (should tend toward 10)	5 orbitals × 2 = 10 (but system limited to 9)

The fractal logic of life is therefore not a statistical accident, but the expression of a universal organizing principle, resonating between the language of quantum physics and that of molecular biology — as will be demonstrated through the simulation of a hypothetical quaternary code.

Run-Length (RL) Distributions Observed at Different Scales

Level of Analysis	RL(1)	RL(2)	RL(3)	RL(4)	RL(5)	Observed Signature
Quaternary Code (256)	5	4	3	2	1	Decreasing staircase (Lmax = 5)
Codons (64)	9	6	3	1	–	Truncated triangular progression (≈ Pascal 1, 3, 6, 10 → stops at 9)
Doublets (16)	3	2	1	–	–	Decreasing staircase (Lmax = 3)
Bases (4)	2	1	–	–	–	Decreasing staircase (Lmax = 2)
Atoms	4	–	–	–	–	Singletons only
Particles	1	1	–	–	–	Minimal alternation (RL(1) and RL(2))

The Hypothetical Quaternary Code

Building on the hypothesis of a Theoretical Codonic Unit (TCU), I undertook the construction of a hypothetical quaternary code. As expected, the predictive values identified within the codons (Tables 1 to 10 in the full article) are fully preserved in this new system. Some of these values even fit directly within it, confirming that the quaternary code does not represent a distinct entity but rather a natural extension of the codon table, in which the numerical invariants maintain their internal coherence.

Ref. Kayser-Cuny, V. (2025). (Part 2) Multiscale Numerical Invariants and Fractal Properties of the Genetic Code: Internal Constraints and Multiscale Packet Distributions Revealing a Universal Grammar. Zenodo. https://doi.org/10.5281/zenodo.17272500

Part 3 – A Unified Theory of Biological Information

I propose that the genetic code functions as a **universal logical automaton**, in the sense of Turing, Shannon, and von Neumann. It self-organizes from its own syntax, encodes **stable binary states** (ON/OFF), and reveals logical symmetries comparable to those seen in fundamental physics. Life, therefore, is not merely biochemistry: **it is first and foremost an autonomous information system**.

This framework allows me to formulate a **unified theory of biological information**, tracing a continuous thread from stellar CHON synthesis to codon-level information patterns. Biology thus appears as a **logical extension of physics**, where matter conforms to internal mathematical laws to give rise to life's self-organization.

Ref. Kayser-Cuny, V. (2025). (Part IV-part 3) Multi-Scale Numerical Invariants and Fractal Properties of the Genetic Code: A Unified Theory of Biological Information, from Stars to Codons. Zenodo. https://doi.org/10.5281/zenodo.17370443

General Conclusion

I defend the view that before it is a molecular structure, **life is pure information**. It is written in an alphabet of numerical constants, obeys an autonomous logical syntax, and organizes itself into **fractal structures** that transcend scale. Life may thus be understood as a **natural mathematical object**, inscribed in the deep logic of the universe.

This approach opens new perspectives in **astrobiology**: if life is an expression of logical invariants, it could exist in forms other than DNA, as long as those constants emerge in observable structures. The identification of life would no longer depend on chemistry, but on the **detection of mathematical organization** — a concept that forms the basis of the *Meta-Genesis* theory.

Complete Primary Data, Computational Materials and Bibliography

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